



## NONPROVISIONAL PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OLIFF & BERRIDGE, PLC  
P.O. Box 19928  
Alexandria, Virginia 22320  
Telephone: (703) 836-6400  
Facsimile: (703) 836-2787

Attorney Docket No.: 106142

Date: June 30, 2000

## BOX PATENT APPLICATION

NONPROVISIONAL APPLICATION TRANSMITTAL  
RULE §1.53(b)

Director of the U.S. Patent and Trademark Office  
Washington, D.C. 20231

Sir:

Transmitted herewith for filing under 37 C.F.R. §1.53(b) is the nonprovisional patent application

For (Title): SYSTEM AND METHOD FOR TEACHING WRITING USING MICROANALYSIS OF TEXT

By (Inventors): Livia POLANYI, Martin Henk VAN DEN BERG, Bee Yian LIEW

- ☒ Formal drawings (Figs. 1-4; 5 sheets) are attached.  
☒ A Declaration and Power of Attorney is filed herewith.  
☒ An assignment of the invention to FUJI XEROX CO., LTD. is filed herewith.  
☒ An Information Disclosure Statement is filed herewith.  
☐ A statement to establish small entity status under 37 C.F.R. §§1.9 and 1.27 is filed herewith.  
☐ A Preliminary Amendment is filed herewith.  
☐ Please amend the specification by inserting before the first line the sentence --This nonprovisional application claims the benefit of U.S. Provisional Application No. \_\_\_\_\_, filed \_\_\_\_\_.--  
☐ Priority of foreign application(s) No. \_\_\_\_\_ filed \_\_\_\_\_ in \_\_\_\_\_ is claimed (35 U.S.C. §119).  
☐ A certified copy of the above corresponding foreign application(s) is filed herewith.  
☒ The filing fee is calculated below:

CLAIMS IN THE APPLICATION AFTER ENTRY OF  
ANY PRELIMINARY AMENDMENT NOTED ABOVE

FOR:	NO. FILED	NO. EXTRA
BASIC FEE		
TOTAL CLAIMS	24 - 20	= 4*
INDEP CLAIMS	2 - 3	= 0*
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIMS PRESENTED		

\* If the difference is less than zero, enter "0".

## SMALL ENTITY

RATE	FEE
	\$ 345
x 9 =	\$
x 39 =	\$
+130 =	\$
TOTAL	\$

OR  
OR  
OR  
OR  
OR  
OROTHER THAN A  
SMALL ENTITY

RATE	FEE
	\$ 690
x 18	\$72
x 78	\$-----
+260	\$-----
TOTAL	\$762

- ☒ Check No. 109900 in the amount of \$762.00 to cover the filing fee is attached. Except as otherwise noted herein, the Director is hereby authorized to charge any other fees that may be required to complete this filing, or to credit any overpayment, to Deposit Account No. 15-0461. Two duplicate copies of this sheet are attached.  
☐ This application is entitled to small entity status. DO NOT charge large entity fees to our Deposit Account.

Respectfully submitted,

James A. Oliff  
Registration No. 27,075

Christian Austin-Hollands  
Registration No. P-46,527

JAO:CAH/cmm

### **Inventor Information**

Inventor One Given Name:: Livia  
Family Name:: POLYANI  
Name Suffix::  
City of Residence:: Palo Alto  
State or Prov. of Residence:: California  
Country of Residence:: United States  
Inventor Two Given Name:: Martin  
Family Name:: VAN DEN BERG  
Name Suffix::  
City of Residence:: Palo Alto  
State or Prov. of Residence:: California  
Country of Residence:: United States  
Inventor Three Given Name:: Bee  
Family Name:: LIEW  
Name Suffix::  
City of Residence:: Cupertino  
State or Prov. of Residence:: California  
Country of Residence:: United States  
Inventor Four Given Name::  
Family Name::  
Name Suffix::  
City of Residence::  
State or Prov. of Residence::  
Country of Residence::  
Inventor Five Given Name ::  
Family Name::  
Name Suffix::  
City of Residence::  
State or Prov. of Residence::  
Country of Residence::

### **Correspondence Information**

Name Line One:: Oliff & Berridge PLC  
Address Line One:: P.O. Box 19928  
City:: Alexandria  
State or Province:: VA  
Postal or Zip Code:: 22320  
Telephone:: (703) 836-6400  
Fax:: (703) 836-2787  
Electronic Mail:: commcenter@oliff.com

### **Application Information**

Title Line One::  
Title Line Two::  
Title Line Three::  
Title Line Four::



## SYSTEM AND METHOD FOR TEACHING WRITING USING MICROANALYSIS OF TEXT

### BACKGROUND OF THE INVENTION

#### 1. Field of Invention

5 This invention is related to machine mediated instruction and computer based learning systems.

#### 2. Description of Related Art

10 Current writing analysis involves human writer review processes. These processes include an instructor or a peer reviewing a written work. These processes can also be computer enhanced by enabling the review process to take place over a computer network, via, for example, email. Alternatively, the review process can take place in computer-enhanced, collaborative-peer-review environments, in which other participants critique the written work.

15 These writing analysis processes suffer from a number of problems. In writing workshops, the instructor reviews the text from the perspective of the target audience. The instructor provides feedback on problematic language. The instructor often indicates a sentence is incorrect but usually does not provide a reader centric microanalysis of the text explaining precisely why the text is incorrect.

20 In fact, reviewers tend to focus on two levels of structure in the review. Since reviewers feel comfortable with grammar checking, the reviewers might perform grammar checking for the entire text. Less frequently, vague or ambiguous sentences may be identified. However, reviewers do not explain why a sentence is vague or ambiguous. The location of the problem is identified and the user is expected to understand how to correct the problem.

25 A second problem stems from the stylistic preferences of each reviewer. A reviewer's subjective style preferences will in turn affect a reviewer's critique of the written work. Thus, instead of receiving an objective indication of how well the work communicated the desired information to the reader, the reviewer may focus on subjective stylistic preferences.

30 Further, the sheer volume of material to be reviewed tends to force a reviewer to focus on relatively easier problems. For example, the writer's overall organization

may be critiqued with only the occasional exemplary sentence construction analyzed in detail.

Outlining tools, such as the "outline view" in the Microsoft Word® word processor application, as well as Xerox Corporation's "Notecards" and EastGate Corporation's "StorySpace" tools, help the writer frame higher level concepts and issues. The writer may then concentrate on developing each of the ideas within a framework. However, these tools do not address the structure and organization of the text below the concept and topic level. Since these tools do not support analyzing how the units of meaning interrelate, they cannot be used to show the writer how to improve the text below the concept and issue level.

Grammar checking tools, such as "Grammatick II" and the grammar tool in Microsoft Word®, apply statistical formulas to a selected text to determine readability based on a variety of different formulae, such as the Flesch Reading Ease Index or the Flesch-Kincaid Grade Level index. These tools also provide sets of rules that can be applied to a written text to identify run-on sentences, sentence fragments, archaic expressions and gender-specific expressions. However, these tools merely indicate whether a text satisfies the rules. Though these tools may provide suggestions for improving a text, based on the identified rule violations, these tools do not provide a structural representation of the text. Therefore, these tools cannot show the user how to improve the relationships of meaning between the units of text.

Text analysis tools, as described in Marcu, "The Rhetorical parsing of natural language texts" Proceedings of the 35<sup>th</sup> Annual Meeting of the Association for Computational Linguistics and the 8<sup>th</sup> Conference of the European Chapter of the Association for Computational Linguistics, Madrid, July, 1997, 96-103 can provide structural representation of a text based on an analytic framework. The system described, for example, is directed to the analysis of texts for the purpose of improved discourse level automatic Natural Language processing. It is not directed to improving the structure or style of the text or to educate the writer in how to improve the organization of future prose works that might be produced.

Rhetorical Structures Theory is a highly complex theory. The basic units of analysis have never been articulated clearly and the several variations of Rhetorical Structures Theory differ from one another in the basic relations between units that they employ. The relations themselves are very complex, overlapping and

ambiguous. For example, classical Rhetorical Structures Theory as developed by Mann and Thompson (1988) includes at least ten presentational relations, five multinuclear relations and fifteen subject matter relations. Training coders is a very lengthy task, requiring weeks of intensive study and supervision. Strong differences of opinion arise among experienced coders about the relationships which link units together. Intercoder reliability is very low. Depending on the level of analysis chosen by different coders, quite different structural trees labeled with Rhetorical Structures relations may be built. Therefore, different Rhetorical Structures Theory analyzers may produce significantly different structural representations from the same text. These factors taken together pose particular problems when attempting to apply Rhetorical Structures Theory in a learning environment where the goal is to help students improve their written communicative skills by applied text micro-analysis.

The Summarist system, as discussed by Hovy and Lin, "Automated Text Summarization in SUMMARIST" in Proceedings of the Workshop of Intelligent Scaleable Text Summarization, July 1997, uses statistical techniques, along with symbolic world knowledge of word meaning based on dictionaries, in attempting to discern a writer's intent. Since the Summarist system uses statistical techniques to identify important keywords, the Summarist system only produces topical keyword summaries.

Thus, these conventional natural language processing systems attempt to identify intended meaning in a text corpus. These systems do not exploit linguistic constraint information provided in the text but instead rely on statistical analysis and word frequency counts. A determination is made, from this statistical information, as to what information the author intended to convey. This information is then used to facilitate queries.

#### SUMMARY OF THE INVENTION

However, the conventional systems described above do not provide a reader-centric analysis of the text and fail to show the writer why the text is incorrect or to provide a basis for determining how to fix the text. Such a reader-centric microanalytic system would be a valuable tool. Instead, these conventional systems focus on the intended meaning of the writer. That is, systems and methods that allow a user to analyze a text corpus from the reader's perspective and to interactively view

This invention provides writing instructions systems and methods for teaching writing skills to a student using an objective reader-centric microanalysis of the text.

This invention separately provides systems and methods for designating important topical information within the text to be analyzed by highlighting or tagging the topical words or phrases.

In various exemplary embodiments, the student classifies the units of meaning by type. The classification may then be reviewed by the reviewer or reviewing system. Following this review by the reviewer or reviewing system, the writer then creates a discourse structural representation that reflects the interrelationships between the units of meaning, consistent with a selected theory of discourse. Optionally, the information designated by the user as important can be displayed in the discourse structure.

An automatically generated summary is optionally created from the discourse structural representation. The summary can then be compared to the topic information designated by the writer as important. The degree of coverage is conveyed as objective feedback to the writer as to how well the text would have conveyed the desired information to the reader. In various exemplary embodiments, the reader centric text analysis systems and methods according to this invention use the Linguistic Discourse Model, although other theories of discourse may be used in place of the Linguistic Discourse Model.

### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, in which like elements are labeled with like numbers, and which:

Fig. 1 shows a block diagram of an exemplary embodiment of the invention;

Fig. 2 shows an exemplary flowchart of the invention;

Fig. 3 shows an exemplary flowchart of the summary algorithm; and

Fig. 4 shows an exemplary discourse structural representation of text.

### DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Fig. 1 shows an exemplary embodiment of an expository writing teaching system 200.

The expository writing teaching system 200 includes a controller 220 connected to an input/output interface 210 and a memory 230. The memory can include one or none of having a text portion 231 a segment portion 232, text building portion 233, summary portion 234 and tree portion 235. The input/output interface 210 is connected by a link 215 to one or more input devices 214 and to a display device 212. The input/output interface 210, the controller 220 and the memory 230 are connected to an optional concept highlighting circuit or routine 240, a segmenting circuit or routine 250, an analyzing circuit or routine 260, a tree building circuit or routine 270, an optional summary generating circuit or routine 280, an optional concept comparator circuit or routine 290 and a reviewing circuit or routine 295 by a data/control bus 205.

A link 110 connects the expository writing teaching system 200 to other devices or components. It will be apparent that the link 110 may also be used to permit remote access to the expository writing teaching system 200 for a user or a reviewer or reviewing system. The link 110 may be any known or later developed device or system for connecting to the expository writing teaching system 200, including a direct cable connection, a connection over a wide area network or a local area network, a connection over an intranet, a connection over the Internet, or a connection over any other distributed processing network or system. In general, the link 110 can be any known or later developed connection system or structure usable to connect a user, a reviewer or a reviewing system to the system for teaching expository writing 200.



The controller 220 stores information in the memory 230. The memory 230 may be implemented using a hard disk and disk drive storage, a floppy disk storage, a re-writable optical disk storage, bubble memory, flash memory, static and/or dynamic RAM, battery-backed RAM, or the like. The controller 220 displays information on the display 212 and accepts user input via the one or more user input devices 214. User inputs to the expository writing teaching system 200 may include one or more of voice input, keyboard input, touch sensitive screen input or any method of entering information into the expository writing teaching system 200.

The user calls up a text to be analyzed from the text memory 231. Alternatively, the user may use any word processor, text processing application or text editor to create a text file to be analyzed. In various exemplary embodiments, once the text has been obtained, whether by importing the text from an existing file in the text memory 231 or created using a text editor, the optional concept highlighting circuit or routine 240 is used to highlight concepts in the text that the user believes to be important. However, it should be appreciated that, in place of, or in addition to, highlighting, other methods for designating important concepts, such as XML tagging, typing the concepts into a pop-up dialog box, or any other known or later developed technique for identifying the important concepts, may be used. It will be appreciated that the expository writing teaching system 200 may also be used without any highlighting.

The user then segments the text into text building units by activating the segmenting circuit or routine 250. Different linguistic theories build discourse from different basic text building units. In various exemplary embodiments, the Linguistic Discourse Model is used to analyze the text and categorize the text building units. The Linguistic Discourse Model used in these exemplary embodiments provides for three distinct types of text building units. Each text building unit represents the smallest unit of meaning in the text. A sentence may have, or be formed from, a single text building unit. However, a sentence is more likely to be formed from several text building units. Using editing features of the segmenting circuit or routine 250, the user breaks up the text to be analyzed into the text building units. In various exemplary embodiments, a line break is inserted between each text building unit. This creates a list of text building units, with one text building unit on each line. However, it should be appreciated that delimiting one text building unit from another

can use any known or later developed delimiting technique. The output of the segmentation circuit 250 or the user segmented text will result in the same list of text building units.

5 The list of text building units to be analyzed is then, under control of the controller 220, provided to the analyzing circuit or routine 260. In the analyzing circuit or routine 260, additional data fields are exposed to the user to allow the user to assign a text building unit type to each text building unit. The user may select a text building unit type for each text building unit based on the theory of discourse chosen to be used for instruction. The determined text building units are then stored in  
10 the text building units memory portion 233.

There are many theories of discourse analysis that may be employed in the writing instruction systems and methods according to this invention. Such theories include, but are not limited to the Discourse Structures Theory, the Rhetorical Structure Theory, the Systemic Functional Grammar and Tagmemics.

15 Various exemplary embodiments of the writing instruction systems and methods according to this invention use the Linguistic Discourse Model theory of discourse analysis. As indicated above, the Linguistic Discourse Model provides for three types of text building units: content text building units; modifier text building units; and operator text building units. Content text building units express some state, action or belief that is an accomplishment or property of some entity. Content text  
20 building units have a verb at their core, whether expressed or unexpressed. Modifier text building units provide context setting information for information encoded further along in the text. Operator text building units provide commentary on aspects of text organization or logical structure or may express emotional reaction to something in  
25 the context. Each text building unit is assigned to one of these categories.

The user may then submit the users work, i.e., the list of text building units, along with the associated text building unit type assignments, to the reviewer or the text reviewing system. The reviewer may use the controller 220, the display 212 and the one or more input devices 214. In this case, the expository writing teaching  
30 system 200 becomes the reviewing system while used by the reviewer to review the user's work. Alternatively, the reviewer or reviewing system may use a different controller connected via a network (not shown) through the input output interface 210

and link 110 to access the users work and to review the text building unit type assignments using the reviewing circuit or routine 295.

When the reviewer, using the reviewing system, views the user's work, an additional field for the reviewer's comments is presented by the reviewing circuit or routine so that the reviewer may respond to the user's comments. The reviewer then analyzes the text building unit types assigned by the user, and provides corrections and/or comments as necessary.

This review may also be performed automatically by a reviewing system that automatically recognizes and assigns a text building unit type to each text building unit. In this case, the comments can be generated based on the user's comments and the differences between the user's work and a "correct" answer. For example, if the reviewing system detects that the user has entered a comment and further detects that the corresponding text building unit has been assigned an inappropriate text building unit type, a system comment may be generated and placed in the reviewer comment field to more fully explain why the user's selection was an inappropriate selection.

After the reviewer or reviewing system has saved the work to the segment portion 232, the user may then re-open the work. The work is then processed, under control of the controller 220, by the tree building circuit or routine 270. The tree building circuit or routine 270 creates a node for the first text building unit of the text and begins by defining this node as the root node of the discourse tree. As additional fields are exposed to the user, the relation fields identify the type of constructed node used to link the text building units into the discourse tree. The node fields allows the user to select an insertion point in the discourse tree for the text building unit that is being analyzed. The text building units are added to the structural representation of the discourse consistent with the particular theory of discourse used in the expository writing teaching system 200. That is, depending on the particular theory of discourse, a particular text building unit can be added to the structural representation of discourse at different points and/or in different ways. In the Linguistic Discourse Model used in various exemplary embodiments of the expository writing teaching system 200, the structural representation is an open right tree.

In various exemplary embodiments, the Linguistic Discourse Model provides three relationships between the text building units: 1) coordinations; 2) subordinations; and 3) binaries. A coordination relationship between two text

building units exists when a second text building unit continues a discourse activity that was previously begun or continued by a first text building unit. In this case, the second text building unit is linked to the discourse tree and the first text building unit with a coordination node.

- 5           In particular, in various exemplary embodiments, if the relation between the second text building unit to be added and text building unit, represented by a first node in the structural representation or tree, is a coordination relationship, the first or existing node is replaced by a new coordination node and the first node becomes a leaf node of the new coordination node. The new coordination node links the first node
- 10           representing the first text building unit as a left child node of the new coordination node into the discourse tree. A second node representing the second text building unit to be added is then linked to the new coordination node as the right child node of the new coordination node. In some cases, a subsequent text building unit may extend the activity carried out by text building units already related to one another in the
- 15           discourse tree as siblings under a coordination node. In this case, a third node representing a third text building unit will be added under the existing coordination node as a new right child node. The second node then becomes a middle child node.

- If the relation between the text building units is not a coordination relationship, the second text building unit is analyzed to determine if that text building
- 20           unit elaborates upon or interrupts an active discourse in the discourse tree. A discourse is active if it has a relationship node or a text building unit that is located along the right edge of the discourse tree. If the second text building unit elaborates upon, or interrupts an active discourse, the relationship between the second text building unit and the previous text building unit is defined as a subordination
- 25           relationship. In this case the first node is replaced by a new subordination node and the first node becomes a leaf node of the subordination node. The second node representing the second text building unit is linked into the discourse tree as the right child node of the new subordination node.

- If none of the relationships between the second text building unit and the first
- 30           text building unit forming the right edge of the discourse tree are either a coordination or a subordination, then the second text building unit is classified as having a binary relationship with the first text building unit in the discourse tree. The first or existing node is replaced by a new binary node and the first node becomes a leaf node of the

binary node. The second node representing the second text building unit is then added as the right child node of the new binary node.

In the embodiment using the Linguistic Discourse Model, the user progresses through the text, and the structural representation of discourse is an open right tree. Accordingly, the nodes representing the text building units are added to the discourse tree only at the right edges of the discourse tree. As a result, the potential insertion points where the next text building unit can be added to the discourse tree can be easily determined and presented to the user. In various exemplary embodiments, the list of insertion points can be displayed to the user in the form of a constrained drop down selection box. Of course, alternate theories of discourse may utilize different structural representations of discourse.

Building the organizational structure using the rules of a discourse theory, such as the Linguistic Discourse Model, allows the user to gain a better understanding of the relationships between the text building units in the user's text. During building of the organizational tree, the user is prompted to understand how the text building units must interrelate in order to convey the desired information to a reader. This tree building process increases the user's understanding of the communicative aspects of the user's own writing. If an ambiguity exists regarding the appropriate insertion point for a text building unit, this ambiguity highlights the ambiguity the reader will experience with respect to the same unit of meaning represented by that next text building unit. Alternatively, tree building may be accomplished automatically. A discourse tree is built reflecting the organization of the text according to the discourse theory being used.

The user may then activate the summary generating circuit or routine 280. Alternatively, the summary generating circuit or routine 280 may be automatically invoked after the tree building circuit or routine 270 has completed processing. The user then selects the level of summary L to be generated. The value for the summary level L ranges from a lowest level, for example 0, representing the most specific level to a highest level P, the most general level. The value of the most general level P reflects the maximal number of subordination levels in the discourse tree. The summary generating circuit or routine 280 takes the structural representation of discourse, which in the various exemplary embodiments employing the Linguistic Discourse Model, is an open right tree generated by the tree building circuit or routine

270, as input, along with the summary level L indicated by the user. The summary generating circuit or routine 280 generates a summary of the structural representation, for the specified summary level L.

After the summary is generated by the summary generating circuit or routine 280, the optional concept comparator circuit or routine 290 may be activated. The concept comparator circuit or routine 290 may be automatically activated when the summary generating circuit or routine 280 completes processing or may be invoked by the user in a separate action. The concept comparator circuit or routine 290 operates on the output of the concept highlighting circuit or routine 240 and the summary generating circuit or routine 280. The concept comparator circuit or routine 290 compares the coverage of the information identified by the concept highlighting circuit or routine 240 to the summary generated by the summary circuit or routine 280. The concept comparator circuit or routine 290 compares the words and/or phrases output by the concept highlighting circuit or routine 240 to those words that also appear in the output of the summary circuit or routine 280.

The user may then receive a numerical ratio or a percentage, or any other suitable method or visualization, that indicates the amount of coverage the text provides to the identified word and/or phrases. The ratio indicates how many of the important words or phrases were conveyed to the virtual reader as indicated by the summary generated by the summary generating circuit or routine 280. The coverage measure may also be conveyed as feedback to the user by displaying the important concepts identified by the highlighting circuit or routine 240. The words and/or phrases output by the highlighting circuit or routine 240 but not found in the summary generated by the summary generating circuit or routine 280 are then displayed in a distinguishing color, such as red. In this way, the user's attention is immediately drawn to the problem areas in the text. Alternatively, the user may optionally view the highlighted portions of the text in a visualization of the structural representation of the discourse.

Fig. 2 is a flowchart outlining one exemplary embodiment of a method for analyzing a written text according to this invention. Beginning in step S100, control continues to step S110, where the user may import a text into a text editing workspace. It will be apparent that the text may be entered directly into the system or the text may be entered into the system using any other method including text

5

10

15

20

30

steps may be accomplished under programmatic control. For example, for a given

user, an individualized lesson plan can be presented and constantly monitored and updated, and a specific text or portion of the text can be selected for analysis to address specific pedagogical requirements of the student.

5 In step S150, a first text building unit is selected. Then, in step S160, a text building unit type is assigned to the selected text building unit using the implemented discourse theory. As discussed above, in various exemplary embodiments, the Linguistic Discourse Model is the implemented theory of discourse. Comments may also be added, in step S160, to the analysis of each text building unit as it is assigned. These comments may serve as temporary notes to the user, may indicate partial  
10 completion, and/or serve to communicate problem areas or pose questions to the reviewer. Next, in step S170, a determination is made whether the last text building unit has been assigned a text building unit type. If the current text building unit is not the last one control continues to step S180. Otherwise control jumps to step S190.

15 In step S180 the next unassigned text building unit is selected. Control then returns to step S160 and the loop continues until the last text building unit needing to be assigned has been processed. Control then jumps to step S190.

20 In step S190, once the user has assigned a text building unit type to each of the text building units according to the relevant theory of discourse, the work is saved to memory. Next, in step S200, the text submitted by the user and opened in the analysis workspace includes the fields seen by the user including text building unit, type and user comments fields. However, the analysis workspace now also includes one or more fields for the reviewer's comments. Any queries may be answered by placing an appropriate response in a corresponding one or more reviewer comment fields.

25 Then, in step S210, a determination is made whether any text building units have been assigned. If any text building units have been inappropriately assigned, control continues to step S220. In step S220, the text building units are selected. Control then jumps back to step S160. Otherwise control jumps to step S230.

30 In step S230, a discourse tree is begun by inserting a node representing a first text building unit as the root node of the discourse tree. As discussed above, the Linguistic Discourse Model implemented in various exemplary embodiments provides three relationships between the text building units: 1) coordinations; 2) subordinations; and 3) binaries.



5           Next, in step S250, a determination is made whether all text building units have been added to the discourse tree. If text building units remain to be added control continues to step S260. In step S260, the next building unit to be added is selected. Control then jumps back to step S240. Otherwise, once all text building units have been assigned, control jumps to optional step S270.

On return, control then continues with optional step S280 where the automatically generated summary can be compared with the concepts previously designated by the user as important. By comparing coverage of user designated important concepts to the automatically generated summary, the user is provided objective feedback as to how well the text has conveyed the desired information.

The objective, reader centric microanalysis of the information conveyed in the written work can be easily compared to the information hoped to be conveyed to the target reader. Control is then transferred to step S299 and the process ends.

Fig. 3 shows an exemplary flowchart of summary generation. Various exemplary embodiments of the expository writing teaching system and method according to this inventions are designed for an English-language expository writing culture. It will be apparent that different languages and genres will be summarized using different summary algorithms. These different summary algorithms can be

determined by analyzing the structure of the discourse tree created by the writing culture and identifying the text building units of importance.

Thus, many implementations of the summary generating technique according to this invention for different writing cultures will be apparent. For example, the summary generator specific to the English Expository writing culture is built upon the English expository convention that calls for the most salient information to be encoded in text units that are structurally dominant in a text.

In the English Expository writing culture, information that gives more detail about a point is conventionally encoded in a text unit that is embedded or subordinated to the more general, more salient information that it elaborates upon. In other writing cultures, different strategies will be used. The most salient information in a document or a passage may be presented at the end of the text, summing up or concluding as it were, what was said before.

In a text microanalysis using the Linguistic Discourse Model, the characteristic deployment of more or less salient information can be determined and a summarization generator devised that extracts information marked as more salient by its structural placement and encoding form before extracting information marked as less salient. Thus, it will be apparent how summary generation may be adapted to create a summary for other languages or writing cultures.

The English fiction writing culture dictates the use of a different structure from the English expository writing culture. For instance, in English fiction, the ambiguities identified by the microanalysis process as potentially confusing in an English expository writing culture may be required in writing a murder mystery. In a murder mystery the ambiguity helps preserves the suspense built up in the text narrative.

The summary generation begins with step S300 of Fig. 3 which reflects an exemplary flowchart of English expository summary generation. It will be apparent that with the appropriate substitution of a summarization system tailored to the specific writing culture, any type of writing in any language may be taught with the methods and systems of the invention. Control is then transferred to step S310.

In step S310, the user enters L, the level of summary desired. The value of the summary level L ranges from a lowest level, for example 0, representing the most specific level to a highest level P, the most general level. The value of the most

general level P reflects the maximal number of subordination levels in the discourse tree. The summary level may be specified for example, by a property selection, a pop-up dialog box, an option setting or any other method. Next, in step S320 where the first node in the tree is assigned the lowest rank, for example 0. Then, in step 5 S330, the child nodes are recursively selected. Control continues to step S340. In step S340, a determination is made if the selected child node is a subordination. If the node is a subordination, control is transferred to step S360. Otherwise if the node is not a subordination, control is transferred to step S350. In contrast, step S360, the rank of the parent node is assigned to the subordinating node. Then in step S370, the 10 rank of the parent node, incremented by 1, is assigned to the subordinated node. Control then continues to step S380.

In this case, the node must be either a coordination or a binary. In either case, in step S350, the selected child node is assigned the rank of the parent node. Control then jumps to step S380.

15 In step S380, a determination is made as to whether any child nodes remain to be processed. If child nodes remain to be processed, control is transferred to step S340 and the type determination and ranking steps are repeated for all remaining child nodes. When no child nodes remain to be processed, control is transferred to step S390.

20 In step S390, all nodes of rank less than or equal to the requested summary level L are selected and output. Next, in optional step S4000, the punctuation may be adjusted to create complete sentences. Then in step S410, control returns to step S280.

25 The exemplary embodiment describes the summarization in terms of the structural representation of a tree. Alternate theories of discourse that can be used in the expository writing teaching systems 200 may provide different structural representations of the text. However, any representational structure in which the salient information can be identified can be used.

Field	410	420	430	440	450	460
#	Text Building Unit	Type	Relation	Node	User Comments	Reviewer Comments
1	John came in through the back door	Content				
2	He walked into the kitchen	Content	Coordination	Coordination, 1-6	Is this a modifier?	
3	He apologized to his wife for being late	Content	Coordination	Coordination, 1-6		
4	He had to visit his mother	Content	Subordination	Subordination, 3-4	Is this a binary?	
5	His mother likes him to come by	Content	Subordination	Subordination, 4-5	Is this a coordination?	No, it is a subordination.
6	His wife said she didn't mind	Content	Coordination	Coordination, 1-6		

Table 1

Table 1 shows an example of a text segmented into text building units 1-6. The text building unit field contains the text building units as segmented by a user. In the exemplary embodiment, after text segmentation and prior to the text building unit type assignment, only the text building unit, type and user comments fields will be visible, since these are the fields used to make the assignments and interact with the reviewer or reviewing system.

When the type assignment is complete and the reviewer opens the file, the reviewer comments field is also exposed for view. When the review is complete and the corrected work submitted, the user may then view and interact with the relation and node fields which are used to link the text building units into the discourse tree.

The type field illustrates the assignment of text building unit type for the entry "He walked into the kitchen." This is a content text building unit. In various exemplary embodiments, the type assignment is entered by positioning the cursor in the cell and clicking the mouse. A constrained drop down selection list appears from which the content, modifier or operator type assignment may be selected. Once all the text building unit type assignments have been made, the file is submitted for review as described above.

After correction and further review as necessary, the text building units can be inserted into the structural representation of the discourse. For each successive text building unit, the user may specify a relationship in the relation field between the next text building unit and text building units that serve as the insertion points in the discourse tree. Using the constructed relation nodes discussed above, and the node

field, the next text building unit may be easily inserted into the discourse tree by providing the user with a drop down list of potential insertion points for the next text building unit. In some cases a subsequent text building unit may extend the activity carried out by text building units already related to one another on the discourse tree as siblings. In this case, the incoming text building unit will be added under the existing node as a next sibling.

Fig. 4 shows an exemplary discourse tree for the exemplary list of text building units shown in Table 1. The tree also includes the ranks of each node generated by summarizing according to the English expository writing culture. The first text building unit is linked to the second text building unit by a coordination node labeled 1-6. As a result each of the text building units is assigned 0, the rank of the parent node. The subordinating node, "He apologized to his wife" inherits the rank of the parent node, which is the subordination node 3-4. However, the rank of the subordinated node, "He had to visit his mother" is assigned the rank of the parent node incremented by one. Similarly the rank of the subordinated node, "His mother likes him to come by" is incremented by two.

Thus, for a summary level of 0, summarizing the discourse tree produces, "John came in through the back door. He walked into the kitchen. He apologized to his wife for being late. His wife said she didn't mind." The summary would not display the subordinations since these text building units are ranked higher than the chosen summary level. In this way, the generated summary provides an indication as to what information the virtual reader would understand the text to convey. This feedback information may then be incorporated by the user into future revisions of the text.

While this invention has been described in conjunction with the specific embodiments outlined above, it is evident that many alternatives exist. For example, the expository writing system 200 may be used with classical Rhetorical Structures Theory of discourse analysis. The system allows for the segmenting of a text into the text building units of the Rhetorical Structures Theory or any other theory of discourse. In the Rhetorical Structures Theory the discourse is built up from nucleus and satellite units that reflect situations presented.

Relations defined between text building units in Rhetorical Structures Theory might rely on such classical Rhetorical Structures Theory relations as: circumstance;

condition; elaboration; evaluation; interpretation; means; non-volitional cause; non-volitional result; otherwise; purpose; solutionhood; unconditional; unless; volitional cause and volitional result as subject matter relations. Presentational relations in classical Rhetorical Structures Theory include: antithesis; background; concession;

5 enablement; evidence; justify; motivation; preparation; restatement; and summary.

The analytic process of building the structural representation of discourse using any theory of discourse allows the user to understand their text as viewed through that analytic framework. Thus, the system and methods may be adapted to Systemic Functional Grammar, Tagmemics or any other known or later developed

10 theory of discourse analysis to teach a user how to write using these theories of discourse analysis.

It should be understood that the expository writing teaching system 200 can be implemented on a programmed general purpose computer. However, the expository writing teaching system 200 can also be implemented on a special purpose computer,

15 a programmed microprocessor or microcontroller and peripheral integrated circuit elements, an ASIC or other integrated circuit, a digital signal processor, a hardwired electronic or logic circuit such as a discrete element circuit, a programmable logic device such as a PLD, PLA, FPGA or PAL, or the like. In general, any device, capable of implementing a finite state machine that is in turn capable of implementing

20 the flowcharts shown in Fig. 2 and 3 may be used to implement the expository writing teaching system 200.

It will be apparent that the processing circuits or routines of expository writing teaching system 200 may be used in collaborative networked learning environments in which some or all of the expository writing teaching system 200 components

25 including the circuits or routines may be distributed throughout the network collaborative environment or located centrally. The environment may include web servers, application servers, or any other type of computer system. In general, the system may be used alone or in combination with any number of other general programmable or special purpose computers or components and in any type of

30 environment including networked collaborative learning environments, client server environments and web based environments.

Modifications and variations will be apparent to those skilled in the art. Accordingly, the exemplary embodiments of the invention, as set forth above, are



WHAT IS CLAIMED IS:

1. A method for teaching expository writing comprising:  
selecting a theory of discourse analysis for teaching writing;  
segmenting a text into at least one text building units based on the  
5 selected theory of discourse;  
analyzing each text building unit according to the selected theory of  
discourse.
2. The method of claim 1, wherein the at least one text building units are  
combined into a structural representation of discourse consistent with the selected  
10 theory of discourse.
3. The method of claim 2, wherein the selected theory of discourse  
analysis is selected from the list of at least Discourse Structures Theory, Linguistic  
Discourse Model, Rhetorical Structure Theory, Systemic Functional Grammar and  
Tagmemics.
- 15 4. The method of claim 1, further comprising, displaying the segmented  
text.
5. The method of claim 1, further comprising, displaying the analyzed  
text.
- 20 6. The method of claim 2, further comprising, displaying the structural  
representation of discourse.
7. The method of claim 1, further comprising, identifying user designated  
important concepts in the text.
8. The method of claim 1, further comprising, generating a summary of  
text based on the selected theory of discourse.
- 25 9. The method of claim 8, further comprising, determining coverage of  
user designated important concepts.
10. The method of claim 9, wherein determining coverage compares user  
designated concepts to the summary.
11. The method of claim 3, wherein the structural representation of  
30 discourse is a tree, and wherein the segmenting is performed automatically and  
wherein the structural representation is displayed.
12. The method of claim 1, wherein the segmenting is performed  
automatically.



13. The method of claim 1 wherein the analysis is performed automatically.

14. The method of claim 8 wherein summary generation comprises the following steps:

- 5 identifying the root node and assigning it a rank;
- recursively selecting each remaining child node;
- for each child node that is a coordination node or a binary node
- assigning the child node the rank of the parent;
- for each child node that is a subordination node;
- 10 assigning to the subordinating node, the rank of the
- parent;
- assigning to the subordinated node, the rank of the
- parent incremented by 1;

15 15. The method of claim 8 wherein a summary is displayed by the steps:

- selecting a summary level  $p$  for a structural representation of
- discourse having a lowest level  $m$  and a highest level  $n$  so that  $m \leq p \leq n$ ;
- walking the nodes of the tree in order of insertion up to the
- level  $p$ ;
- displaying the nodes traversed.

20 16. A system for teaching expository writing comprising:

- an input device;
- a display device;
- a memory;
- a segmenting circuit;
- 25 an analyzing circuit;
- a controller that selects a theory of discourse from the input
- device, segments a text received from the memory to create at least one text building
- unit according to the selected theory of discourse, analyzes the at least one text
- building unit according to the selected theory of discourse and displays the text
- 30 building units.

17. The system of claim 16, further comprising a reviewing circuit that reviews the analyzed text building units for consistency with the selected theory of discourse.

5

10

20

21. The system of claim 20, wherein the summary generating circuit identifies the root node and assigns it a rank; recursively selects each remaining child node and for each child node that is a coordination node or a binary node, assigns each remaining child node the rank of the parent; for each child node that is a subordination node, assigns the rank of the parent to the subordinating node and the rank of the parent + 1 to the subordinated node.

15

23. The system of claim 22, wherein the concept comparator circuit provides a ratio of words from the user designated important concepts that are identified in the summary.

24. The system of claim 18, wherein the structural representation is a tree structure.

2 (D) 4

10

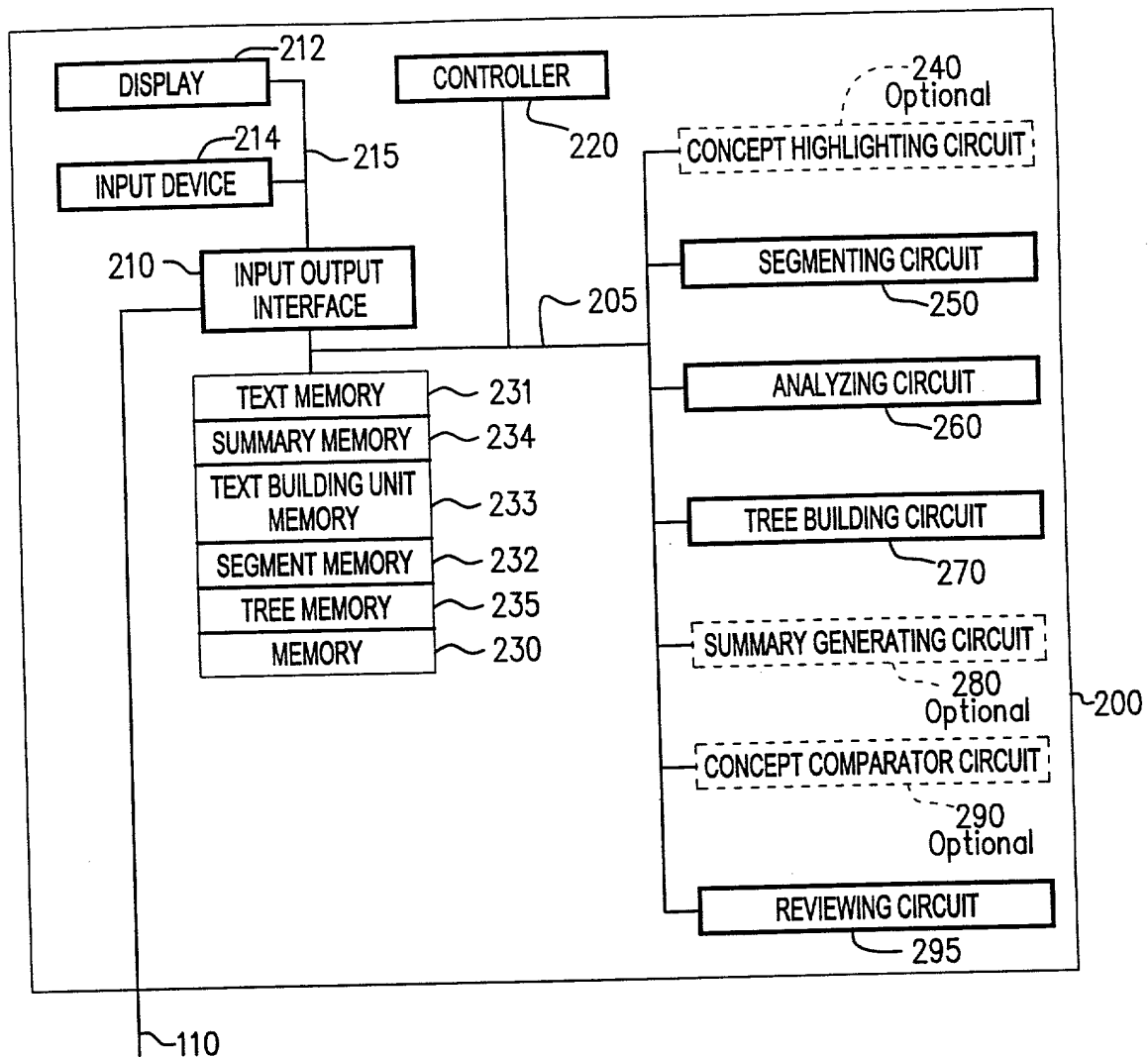


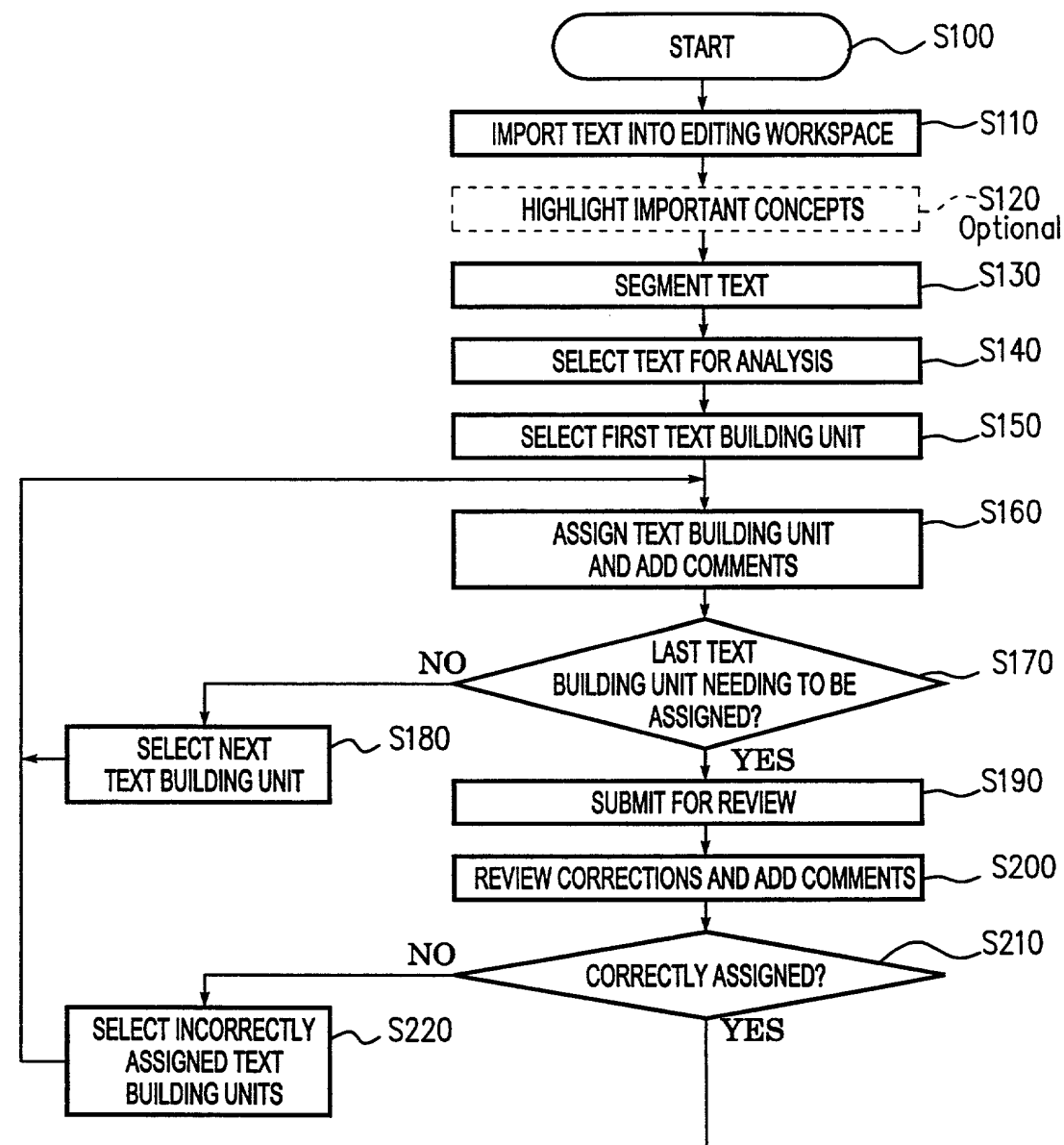
Fig. 1

Fig. 2A

Fig. 2

Fig. 2A

Fig. 2B

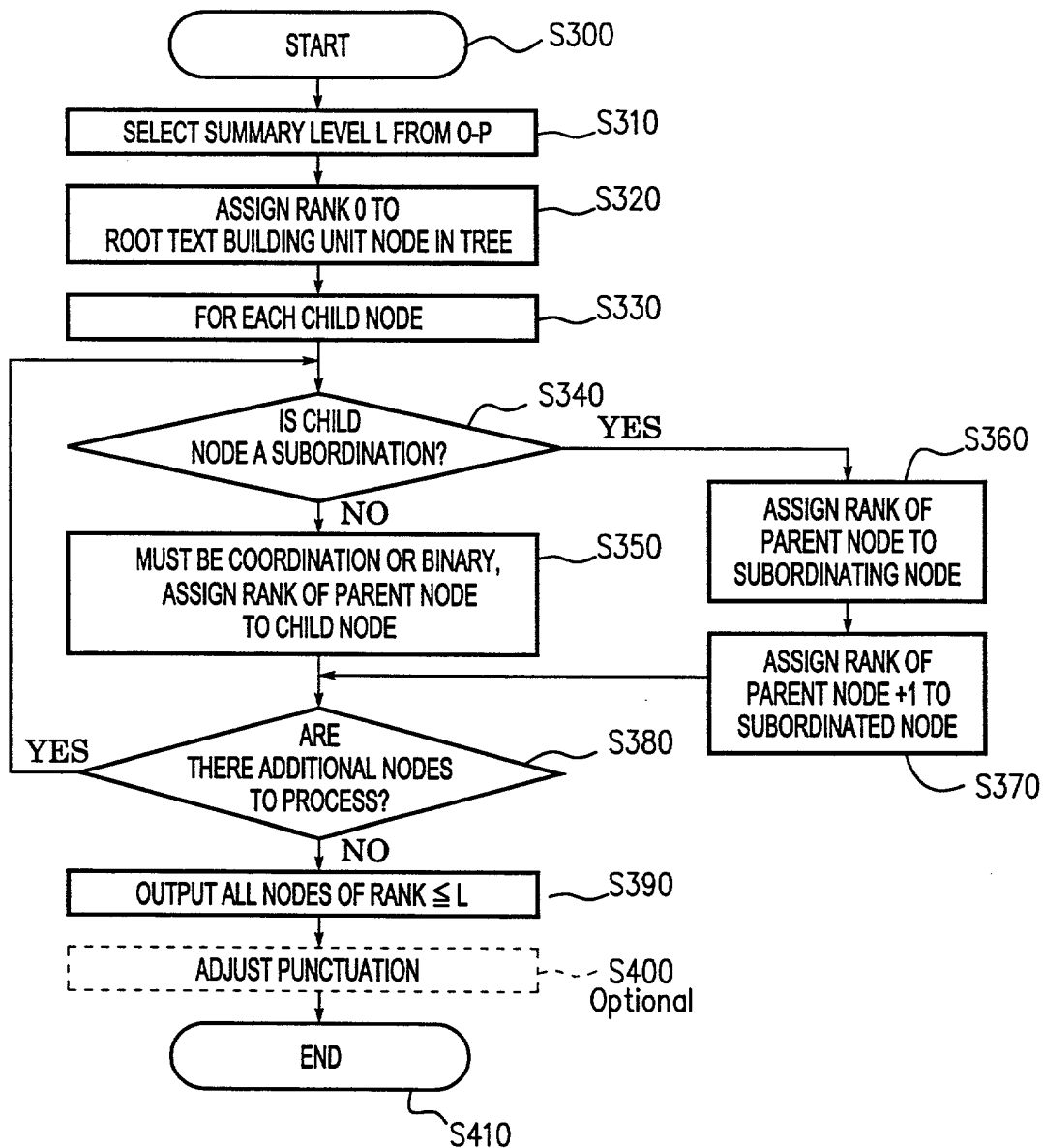


```

graph TD
    S230[ASSIGN FIRST TEXT BUILDING UNIT TO ROOT OF TREE] --> S240[ASSIGN RELATION BETWEEN NEXT TEXT BUILDING UNIT AND TEXT BUILDING UNITS IN TREE]
    S240 --> S250{TEXT BUILDING UNITS NOT YET ADDED TO TREE?}
    S250 -- YES --> S260[SELECT TEXT BUILDING UNIT TO BE ADDED]
    S260 --> S240
    S250 -- NO --> S270[GENERATE SUMMARY]
    S270 -.-> S280[COMPARE SUMMARY COVERAGE OF IMPORTANT CONCEPTS]
    S280 -.-> S290[GENERATE COVERAGE FEEDBACK]
    S290 -.-> S299([END])

```

**Fig. 2B**



**Fig. 3**





**APPLICATION FOR UNITED STATES PATENT  
DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that:  
My residence, post office address and citizenship are as stated below next to my name; that  
I verily believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor  
(if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:  
SYSTEM AND METHOD FOR TEACHING WRITING USING MICROANALYSIS OF TEXT  
described and claimed in the specification;

**Check one**

- \*a. ☒ attached hereto.  
b. ☐ filed on \_\_\_\_\_ as Application No. \_\_\_\_\_ and amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

Under Title 35, U.S. Code §119, the priority benefits of the following foreign application(s) and/or United States provisional application(s) filed by me or my legal representatives or assigns within one year prior to this application are hereby claimed:

None

The following application(s) for patent or inventor's certificate on this invention were filed in countries foreign to the United States of America either (a) more than one year prior to this application, or (b) before the filing date of the above-named foreign priority application(s) and/or United States provisional application(s):

**NOTE**

I hereby appoint the following as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent Office:

**James A. Oliff, Reg. No. 27,075; William P. Berridge, Reg. No. 30,024;**

**Kirk M. Hudson, Reg. No. 27,562; Thomas J. Pardini, Reg. No. 30,411;**

Edward P. Walker, Reg. No. 31,450; Robert A. Miller, Reg. No. 32,771;

**Mario A. Costantino, Reg. No. 33,565; and Stephen J. Roe, Registration No. 34,463.**

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO OLIFF & BERRIDGE, PLC, P.O. BOX 19928, ALEXANDRIA, VIRGINIA 22320, TELEPHONE (703) 836-6400.

I hereby declare that I have reviewed and understand the contents of this Declaration, and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1 ***Typewritten Full Name***  
***of First or Sole Inventor***

Livia

POLANYI

Given Name

**Middle Initial**

**Family Name**

2      **\*\*Inventor's Signature:**

3 \*\*\*Date of Signature:

Month

Day 1

Year

**Residence:**

Palo Alto

California

U.S.A.

**Citizenship:**

City

State or Province

Country

Post Office Address:

(Insert complete)

1037 Villa Vista

mailing address.

Palo Alto, California 94306, U.S.A.

\*If Box (a.) is checked, this form may be executed only when attached to the specification (including claims).

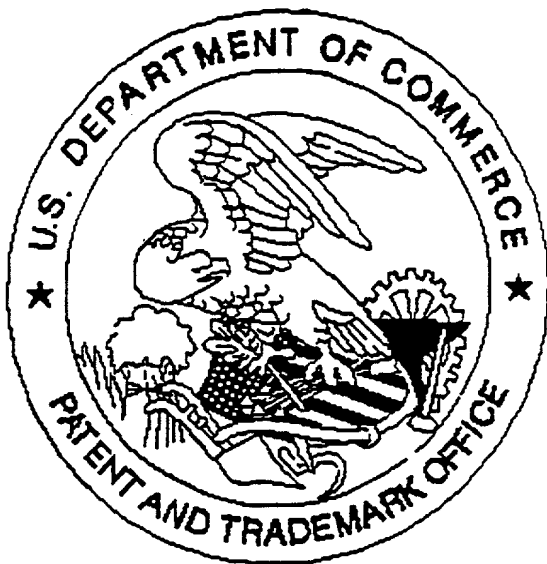
**\*\*Note to Inventor: Please sign name exactly as it appears above and insert actual date of signing.**

IF THERE IS MORE THAN ONE INVENTOR USE PAGE 2 AND PLACE AN "X" HERE. ☒

[illegible]



United States Patent & Trademark Office  
Office of Initial Patent Examination -- Scanning Division



Application deficiencies were found during scanning:

☐ Page(s) \_\_\_\_\_ of \_\_\_\_\_ were not present  
for scanning. (Document title)

☐ Page(s) \_\_\_\_\_ of \_\_\_\_\_ were not present  
for scanning. (Document title)

☒ Scanned copy is best available. *of declarations*

000290-5260960